Extracorporeal Membrane Oxygenation as a Bridge to Lung Transplantation: First Polish Experience

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ABSTRACT

Background. Lung transplantation remains the only viable option for patients with end-stage lung diseases. However, due to an insufficient number of lung donors, many potential candidates die without undergoing the procedure. In the cases of some patients, bridges to transplantation can be implemented. One such method is extracorporeal membrane oxygenation (ECMO), which, depending on the type, has the ability to replace patients' circulatory and respiratory function.

Case presentation. This case study describes 4 cases of patients, who were successfully bridged to lung transplantation. The first patient developed respiratory failure as a result of acute pulmonary embolisms. His respiratory function was insufficient and he had ECMO implanted for 84 days until he was transplanted. Another patient presented respiratory failure due to massive bleeding, which occurred during transbronchial lung biopsy. Such event led to extensive exacerbation, which resulted in using ECMO as a bridge to recovery at first, but later a bridge to lung transplantation. The patient became a lung graft recipient after 14 days on ECMO. The third patient was a woman who developed severe respiratory failure during the course of the progression of her underlying disease. She was treated with ECMO for 14 days as well, and she also underwent lung transplantation. The fourth patient was qualified for retransplantation. She was bridged to retransplantation via veno-venous ECMO.

Conclusion. ECMO can be used a bridge to lung transplantation for suitable patients even for a long period of time, given that it is maintained in accordance with the guidelines.

EXTRACORPOREAL membrane oxygenation (ECMO) provides respiratory or cardiorespiratory support for critically ill patients. It is estimated by the Extracorporeal Life Support Organization Registry that this device helped more than 65,000 patients worldwide since 1989 [1,2]. Two main modes of ECMO include veno-venous (VV) and veno-arterial (VA). The first one is used for patients in critical respiratory failure. Additional impairment of circulation requires the veno-arterial one. ECMO is applicable among children and adults. Since it has been implemented for the first time 40 years ago, it has evolved from a device associated with poor patient outcome and frequent complication to one of the leading bridges to recovery from pulmonary failure or as a bridge to lung transplantation [3]. This change was possible due to technical advancements, as well as advancing knowledge about such devices over the years. ECMO can be safely used for extended periods of time to optimize critically ill patients [4]. In case of lack of respiratory improvement among patients already qualified, or at least during qualification to lung transplantation, bridging to transplantation by means of ECMO can provide satisfactory results. However, this procedure requires thorough management, which is considered challenging [5]. It was reported that one of the longest successful bridge to transplantations lasted 107 days

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[6]. Recent studies report that although implemented by an experienced team, results of lung transplantation do not differ in comparison to patients who did not require such support before transplantation [7–9]. The aim of this study was to assess the 4 cases of patients bridged to lung transplantation by means of ECMO in a single center.

CASE SERIES PRESENTATION

Three out of the 4 patients were bridged to primary lung transplantation. The remaining patient was a previous single lung recipient awaiting retransplantation.

Patient Number 1

A 42-year-old male patient was admitted to the Silesian Center for Heart Diseases due to massive acute pulmonary embolism. At admission, he was hemodynamically unstable and required urgent cardiothoracic surgery. Additionally he suffered from impaired glucose tolerance, mild liver disease, and acute renal failure. After embolectomy, there was severe bleeding to the right bronchus. As other interventions failed to stop the hemorrhage, it was decided to make a resection of the middle lobe. ECMO VA was implemented due to symptoms of right ventricle failure unresponsive to pharmacologic treatment. After a few days, ECMO VA was weaned off. The patient remained on mechanical ventilation and medium doses of catecholamine, and he had his diuresis pharmacologically forced. A couple of days later, arterial blood gases showed progressively worse results. The patient was diagnosed with respiratory failure and ECMO VV was implemented. As the patient was awake and there was a slight chance of recovery, the qualification process for lung transplantation was initiated. The patient was qualified, and after 90 consecutive days spent on ECMO VV he became a single left lung recipient due to complete paralysis of the right phrenic nerve. Due to the long time spent in the horizontal position without a chance of proper movement, the patient required 2 weeks of respiratory support by means of mechanical ventilation via tracheostomy, as well as intense rehabilitation. He was then discharged after 3 weeks in general good condition.

Patient Number 2

A 48-year-old male patient who became a double lung transplant recipient due to respiratory failure developed advanced nonspecific interstitial pneumonia complicated by massive bleeding during transbronchial lung biopsy. It was reported that he had a history of chronic sinusitis as and had underwent 2 procedures, right hip joint arthroplasty due to necrosis of the femoral head and nasal septum correction with polypectomy of the maxillary sinuses 5 and 6 years prior to lung transplantation, respectively. The first signs of interstitial lesions were described as patchy densifications at hilar level, as they were visible on chest radiograph in 2015. The patient was re-admitted as his pulmonary symptoms intensified (dyspnea, decreased exercise tolerance). In April 2018, the patient noticed sudden shortness of breath with paroxysmal cough while running after a several months-long break from physical activity. Various biochemical assessment and noninvasive test were not able to determine the exact type of the disease. It was decided by his primary care pulmonology department to perform a biopsy. During hospitalization, bronchoscopy was performed. Unfortunately, this procedure was complicated with massive bleeding, which led to exacerbation of the underlying disease. Due to developing respiratory failure, the patient was transferred to intensive care unit (ICU), where he was intubated. No progress was noted, so our facility was contacted for potential qualification to lung transplantation. Due to the patient's deteriorating state the decision was made to introduce ECMO as a bridge to transient recovery or to lung transplantation. Three out of 4 lung transplantation centers in Poland refused to perform such transplantation, especially that suspicion of coronary artery disease has been raised (calcium score of 800 in previously performed chest computed tomography). The decision was made to transfer the patient by an aircraft to the Silesian Center for Heart Disease in Zabrze after introducing an ECMO device by the team of prof. P. Suwalski from Ministry of Interior and Administration hospital in Warsaw. After transferring the patient to our center, the angiocoronarography was performed on the patient with implanted working ECMO, and coronary artery disease was ruled out. Bronchoscope interventions performed for the next 2 weeks, as well as optimal ventilation during working ECMO, did not bring desired result (lungs did not regain their functional status). Repeated attempts to reduce respiratory support by ECMO failed (defined as rapid desaturation). Therefore, the decision was made to begin the qualification process for lung transplantation due to pulmonary fibrosis. After 2 weeks of such treatment a matching donor was reported. Double lung transplantation took place. He was discharged after a few weeks in good general condition. He reached 1-year survival last month.

Patient Number 3

A 24-year-old female patient was admitted in April 2019 in general stable condition in order to begin the process of qualification for lung transplantation. She was oxygen dependent. She was to be qualified for lung transplantation due to severe graft-vs-host disease, which she developed after hematopoietic stem cells transplantation due to leukemia, which she suffered from 8 years prior to qualification. This type of graft-vs-host disease patient suffered from attacks on few organs, but the biggest impairment and loss of function was associated with the lungs. Prior to her first visit in this facility, she was diagnosed with recurrent bilateral pulmonary edemas treated with pleurodesis. She underwent several lung resections. She was consulted by a lung transplant facility in Vienna, where she was disqualified due to severity of her condition. She was initially qualified for lung transplantation in May. Soon after, her condition worsened as she was hospitalized in the ICU. When invasive mechanical ventilation did not provide satisfactory results, the decision was made to apply ECMO VV in the ICU. The

patient was then transported on ECMO VV to our facility, where she was awaiting lung transplantation for 14 days in an awake state. She was under constant supervision of medical professionals and psychologists. She underwent double lung transplantation complicated with severe hemostatic disorders. She died at the end of the procedure. Nevertheless, she was given a chance at surviving by successful bridging to transplantation.

Patient Number 4

A 41-year-old female who underwent single left lung transplantation due to hypersensitivity pneumonitis was the next patient. At the time of the initial procedure, right lung transplantation was withdrawn due to suspicion of massive pleural adhesions. In the post-transplant course, she developed chronic rejection, as well as frequent infections from pathogens, which was difficult to eradicate due to significantly destroyed tissue of the native lung. Her state got worse after 1.5 years after primary transplantation. She became oxygen dependent and her arterial blood gases revealed total respiratory failure. She underwent extensive testing enabling qualification to retransplantation. Even though she was qualified at the right moment, her rare blood type (B), short height, and restrictive lung disease made finding the proper donor difficult. Due to her deteriorating state, she was treated with mechanical ventilation, which did not provide satisfactory results. She had ECMO VV implemented and was awaiting an available donor. This was reported after 2 days on ECMO. She underwent double lung transplantation. Due to hemostatic problems connected to right pleura, she had to be reoperated on. Her state was improving. Unfortunately, later in the early post-transplant period she underwent sudden cardiac arrest with cardiopulmonary resuscitation lasting more than an hour with final application of ECMO VA. The patient was successfully weaned of such support with good general cardiac function but in need of mechanical ventilation. After sudden cardiac arrest she did not regain consciousness and died after a month.

DISCUSSION

This study describes the first cases of successful bridging to lung transplantation in Poland. It is reported that patients, who are in need of ECMO as a bridge to lung transplantation present the ultimate respiratory failure. All of the patients described in our study were successfully bridged to lung transplantation. As it was reported by Zwischenberger, in the one of the most experienced ECMO facilities only 74% of patients with severe respiratory failure were weaned from ECMO and 64% survived to hospital discharge. This way of treatment can increase a chance for lung transplantation as an ultimate bridge, but also has very serious complications. Patient number 3 experienced the most common one—hemostatic disorders. That is why thorough management by an experienced team is required. A study published by Tipograf et al presents German experience with this method of bridging [7]. Their results prove that patients bridged with ECMO can provide survival results not statistically different from those who did not require such assistance before transplantation. This finding is also supported by results published by 2 American lung transplant programs. Halpern et al report that patients undergoing bridging to transplantation by means of ECMO at centers that perform more than 35 lung transplantations annually have equivalent mortality to those who do not require ECMO before transplantation [8]. This result is particularly encouraging, as this year (2019) our team reached 35 lung transplantations for the first time in the history of the entire lung transplant program of Silesian Center for Heart Diseases in Zabrze. Another American research team led by Hakim also confirmed that ECMO support before transplantation will not lead to worse results [9]. They also point out the importance of careful selection of potential ECMO candidates, as well as early implementation in order to preserve patients' vitality by exercising with a physiotherapist, proper feeding, and so on.

CONCLUSIONS

This case series reports the first 4 successful cases of bridging to lung transplantation in Poland. As the experience of this lung transplant program grows, we are encouraged by results of the high-volume programs to continue this way of bridging to lung transplantation.

REFERENCES

[1] Zwischenberger JB. Dr. Robert Bartlett and his lifelong accomplishments in the field of extracorporeal membrane oxygenation. ASAIO J 2015;61:1. https://doi.org/10.1097/MAT.0000000000000189.

[2] Cavarocchi NC. Introduction to extracorporeal membrane oxygenation. Crit Care Clin 2017;33:763–6. https://doi.org/10.1016/j.ccc.2017.06.001.

[3] Diaz-Guzman E, Hoopes CW, Zwischenberger JB. The evolution of extracorporeal life support as a bridge to lung transplantation. ASAIO J 2013;59:3–10. https://doi.org/10.1097/MAT.0b013e31827461c2.

[4] Biscotti M, Sonett J, Bacchetta M. ECMO as bridge to lung transplant. Thorac Surg Clin 2015;25:17–25. https://doi.org/10.1016/j.thorsurg.2014.09.010.

[5] Gottlieb J, Greer M. Recent advances in extracorporeal life support as a bridge to lung transplantation. Expert Rev Respir Med 2018;12:217–25. https://doi.org/10.1080/17476348.2018.1433035.

[6] Iacono A, Groves S, Garcia J, Griffith B. Lung transplantation following 107 days of extracorporeal membrane oxygenation. Eur J Cardiothorac Surg 2010;37:969–71. https://doi.org/10.1016/j.ejcts.2009.09.039.

[7] Tipograf Y, Salna M, Minko E, Grogan EL, Agerstrand C, Sonett J, et al. Outcomes of extracorporeal membrane oxygenation as a bridge to lung transplantation. Ann Thorac Surg 2019;107:1456–63. https://doi.org/10.1016/j.athoracsur.2019.01.032.

[8] Halpern AL, Kohtz PD, Helmkamp L, Eldeiry M, Hodges MM, Scott CD, et al. Improved mortality associated with the use of extracorporeal membrane oxygenation. Ann Thorac Surg 2019;108:350–7. https://doi.org/10.1016/j.athoracsur.2019.03.057.

[9] Hakim AH, Ahmad U, McCurry KR, Johnston DR, Pettersson GB, Budev M, et al. Contemporary outcomes of extracorporeal membrane oxygenation used as bridge to lung transplantation. Ann Thorac Surg 2018;106:192–8. https://doi.org/10.1016/j.athoracsur.2018.02.036.